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REPORT

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RESIDUAL EFFECTS OF ATOMIC RADIATION IN SOILS ON SEED GERMINATION

APPENDIX NO. 13

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RESIDUAL EFFECTS OF ATOMIC RADIATION IN SOILS ON SEED GERMINATION.

(21) Report ~~of Naval Medical Research Section, Joint Task Force One~~, on Biological Aspects of Atomic Bomb Tests.
See also Appendix no. 11, AD-473 090.
(1) Appendix No. 13 to Final rept.)

By

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(193 600)

INTRODUCTION

The advent of the atomic bomb raised several questions. Its destructive power was emphatically demonstrated through its use in war. In the postwar tests at Bikini it was decided to attack some of the problems raised by its development and use.

Geneticists are convinced that exposure to X-rays and similar radiations greatly speed up the appearance of mutations. It was desirable to define the residual effects of atomic radiation on soil.

Thirty-six samples of three soils, namely Caribou loam from Maine, Decatur clay loam from Georgia, and Houston clay from Texas were sent to Joint Task Force ONE in the Pacific through Captain R. H. Draeger of the U. S. Navy. The samples and were placed on ships at varying distances from the target. After exposure on 1 July 1946, all but three samples, ~~which were lost on the carrier USS INDEPENDENCE,~~ were returned for examination.

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EXPERIMENTAL PROCEDURE

Tweleve samples of each of three soils, Caribou loam from Maine, Decatur clay from Georgia, and Houston clay from Texas were placed in canvas bags and sealed with pliofilm. The distribution of these soil samples on target ships at Bikini is given in table 1.

The soil samples were returned in their original sealed bags. They were examined with the Geiger counter for residual radiation on the date of their return (19 July 1946). (See Table 2).

The soil samples were then placed in No. 1 tin cans and twenty-five seeds of 1945 Pan-American tomato or Tift Sudan grass No. 22919 were planted. After germination counts were completed the plants were thinned to three per can to insure growth to maturity. Frequent

Table 1.

LOCATION OF SOIL SAMPLES IN ATOMIC BOMB TEST AT BIKINI

Soil Type	Ship	Yards from Bomb	Location on Ship
A-1	USS INDEPENDENCE	657	Pilot House
B-1	USS INDEPENDENCE	657	Pilot House
C-1	USS INDEPENDENCE	657	Pilot House
A-2	USS INDEPENDENCE	664	Flight Deck
B-2	USS INDEPENDENCE	664	Flight Deck
C-2	USS INDEPENDENCE	664	Flight Deck
A-3	USS PENNSYLVANIA	1663	Pilot House
B-3	USS PENNSYLVANIA	1663	Pilot House
C-3	USS PENNSYLVANIA	1663	Pilot House
A-4	USS PENNSYLVANIA	1703	Forward Head
B-4	USS PENNSYLVANIA	1703	Forward Head
C-4	USS PENNSYLVANIA	1703	Forward Head
A-5	USS FALLON	1362	Wheel House
B-5	USS FALLON	1362	Wheel House
C-5	USS FALLON	1362	Wheel House
A-6	USS FALLON	1359	Sr. Troop Officer's Head
B-6	USS FALLON	1359	Sr. Troop Officer's Head
C-6	USS FALLON	1359	Sr. Troop Officer's Head
A-7	USS FALLON	1359	20 mm. Platform
B-7	USS FALLON	1359	20 mm. Platform
C-7	USS FALLON	1359	20 mm. Platform
A-8	USS CATRON	1832	Wheel House
B-8	USS CATRON	1832	Wheel House
C-8	USS CATRON	1832	Wheel House
A-9	USS CATRON	1834	Sr. Troop Officer's Head
B-9	USS CATRON	1834	Sr. Troop Officer's Head
C-9	USS CATRON	1834	Sr. Troop Officer's Head
A-10	USS CATRON	1831	20 mm. Platform
B-10	USS CATRON	1831	20 mm. Platform
C-10	USS CATRON	1831	20 mm. Platform
A-11	USS PARCHE	1528	Submarine
B-11	USS PARCHE	1528	Submarine
C-11	USS PARCHE	1528	Submarine
A-12	USS PARCHE	1528	Submarine
B-12	USS PARCHE	1528	Submarine
C-12	USS PARCHE	1528	Submarine

Note: No controls were kept on the laboratory ship, USS BURLESON.

Table 2.

GEIGER COUNTER ANALYSIS OF EXPOSED SOILS - 19 JULY 1946

Sample	Counts per Minute
Background	171
Large bag (3 small bags)	179
Single small bag (A-1)	184
Soil in evaporating dish (A-11)	208
Background	182
Soil in evaporating dish (B-12)	198
Single small bag (C-5)	179
Soil in evaporating dish (C-5)	179
Single small bag (C-4)	163
Soil in evaporating dish (Decatur blank)	152
Background	120
Background	126
Soil in evaporating dish (Caribou blank)	136
Soil in evaporating dish (A-11)	126

examinations were made of the growing plants to detect abnormalities. The size of the samples limited the number of replications in the greenhouse experiments to two and the number of types of seed tested to two.

Unexposed samples of each of the three types of soil were used in the controlled laboratory and greenhouse tests to give the required checks.

RESULTS

Determinations of pH were made as soon as the samples were received and checked for radiation. The results are recorded in table 3.

TABLE 3

pH Determinations of Soil Samples

Soil Type	pH	Soil Type	pH	Soil Type	pH
Houston A-1	7.54	Caribou B-1	4.51	Decatur C-1	5.52
A-2	lost	B-2	lost	C-2	lost
A-3	7.55	B-3	4.51	C-3	5.52
A-4	7.54	B-4	4.52	C-4	5.51
A-5	7.56	B-5	4.52	C-5	5.52
A-6	7.55	B-6	4.51	C-6	5.50
A-7	7.56	B-7	4.53	C-7	5.52
A-8	7.55	B-8	4.53	C-8	5.52
A-9	7.56	B-9	4.53	C-9	5.52
A-10	7.56	B-10	4.54	C-10	5.52
A-11	7.56	B-11	4.55	C-11	5.51
A-12	7.54	B-12	4.55	C-12	5.53
Houston check	7.54	Caribou check	4.52	Decatur check	5.50

The data indicate no significant differences among the exposed and unexposed samples. On the basis of these results additional chemical analyses were postponed. An analysis of the results of the greenhouse studies made other chemical determinations unnecessary.

The results of the laboratory germination tests at alternating temperatures of 20° and 30° C. are recorded in table 4. They represent duplicate tests of 100 seeds each. Photographs of the control labora-

tory tests are shown in Figures 1 and 2.

Table 4.

Laboratory Germination of Seeds Used in Greenhouse Studies

Medium	Germination of Seed of			
	Tomato		Sudan Grass	
	% Normal	% Abnormal	% Normal	% Abnormal
Blotters	83.5	2.5	89.0	2.0
Houston *	73.5	-	90.0	1.5
Caribou *	84.5	-	90.5	0.0
Decatur *	79.5	-	90.0	1.0

* Unexposed soil

The germination records of the greenhouse tests were taken as follows: Counts of tomato were made at 14 days with a few late seedlings added after 28 days. The Sudan grass data were recorded at 11 days with a few seedlings added after 25 days. The results are listed in table 5.

An analysis of the data shows no significant differences in seed germination in exposed and unexposed soil.

Differences in character of growth were noted in plants from exposed seeds, and it was decided to carry the plants to maturity. Variations in growth were noted but were diagnosed as nutrient deficiencies. At the termination of the experiment on October 23 the plants in the Houston and Decatur soils showed evidence of malnutrition. The physical condition of these heavy clay soils was diagnosed as the limiting factor of growth. Continued growth in these soils would have added no useful information. The plants in the Caribou soils showed near normal growth with healthy tomato plants over 12 inches in height and Sudan grass over 36 inches in height. Normal growth would have resulted in season. The normal appearance of the blooming Sudan grass

Table 5.

GERMINATION OF SEEDS IN GREENHOUSE STUDIES OF EXPOSED SOILS

Soil	Number of Seedlings					
	Houston		Caribou		Decatur	
	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Tomato - Planted 7-26-46						
1	17	2		0	14	1
3	16	3	19	2	19	2
4	17	0	20	1	20	0
5	20	0	12	1	22	0
6	16	2	21	0	19	1
7	16	3	18	2	23	0
8	18	1	17	0	18	0
9	17	2	17	1	20	1
10	16	1	18	1	17	1
11	17	1	16	1	19	0
12	18	1	15	1	16	2
Control	21	0	23	0	19	0
Sudan Grass - Planted 7-29-46						
1	19	1	24	0	19	0
3	22	0	20	0	10	0
4	21	1	23	0	14	5
5	24	0	22	0	17	3
6	21	1	19	0	18	0
7	21	1	23	1	15	2
8	20	1	15	5	14	0
9	21	0	21	0	13	1
10	24	0	21	3	13	3
11	20	1	23	1	19	0
12	21	1	19	1	19	1

Note: 25 seeds planted in each container.

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and the tomato plants in the Caribou soils give supporting evidence to the belief that the effects of atomic bomb ionizing radiation on soils is short lived.

CONCLUSIONS

On the basis of limited laboratory and greenhouse tests the following conclusions may be drawn:

1. The residual radiation in dry soil which had been directly exposed to the atomic bomb ionizing radiation within 650 to 1800 yards is reduced to low levels within a period of two weeks after exposure.

2. Plants of tomato and Sudan grass planted in these irradiated soils grew normally to maturity. No significant differences in seed germination were obtained.

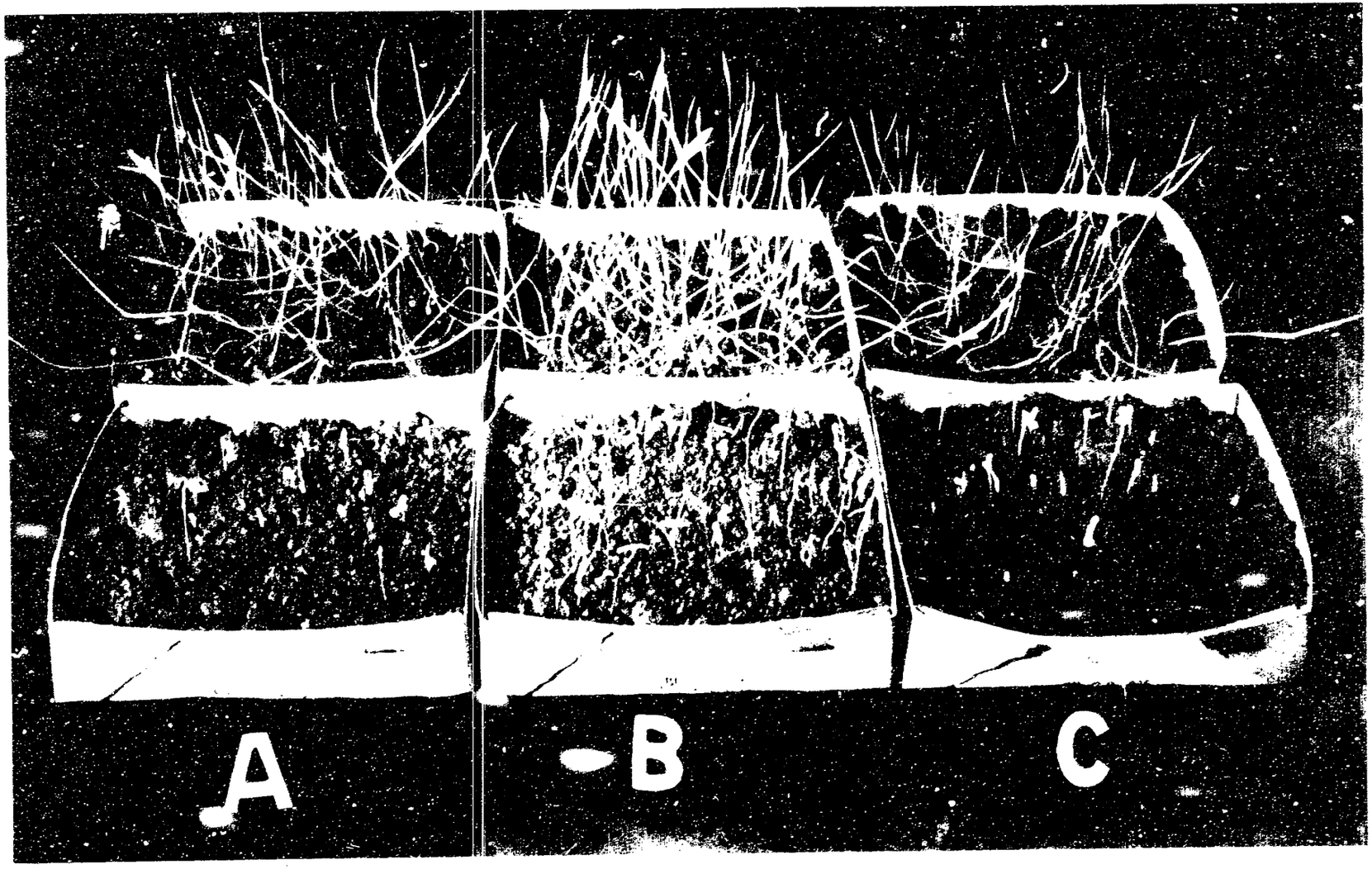
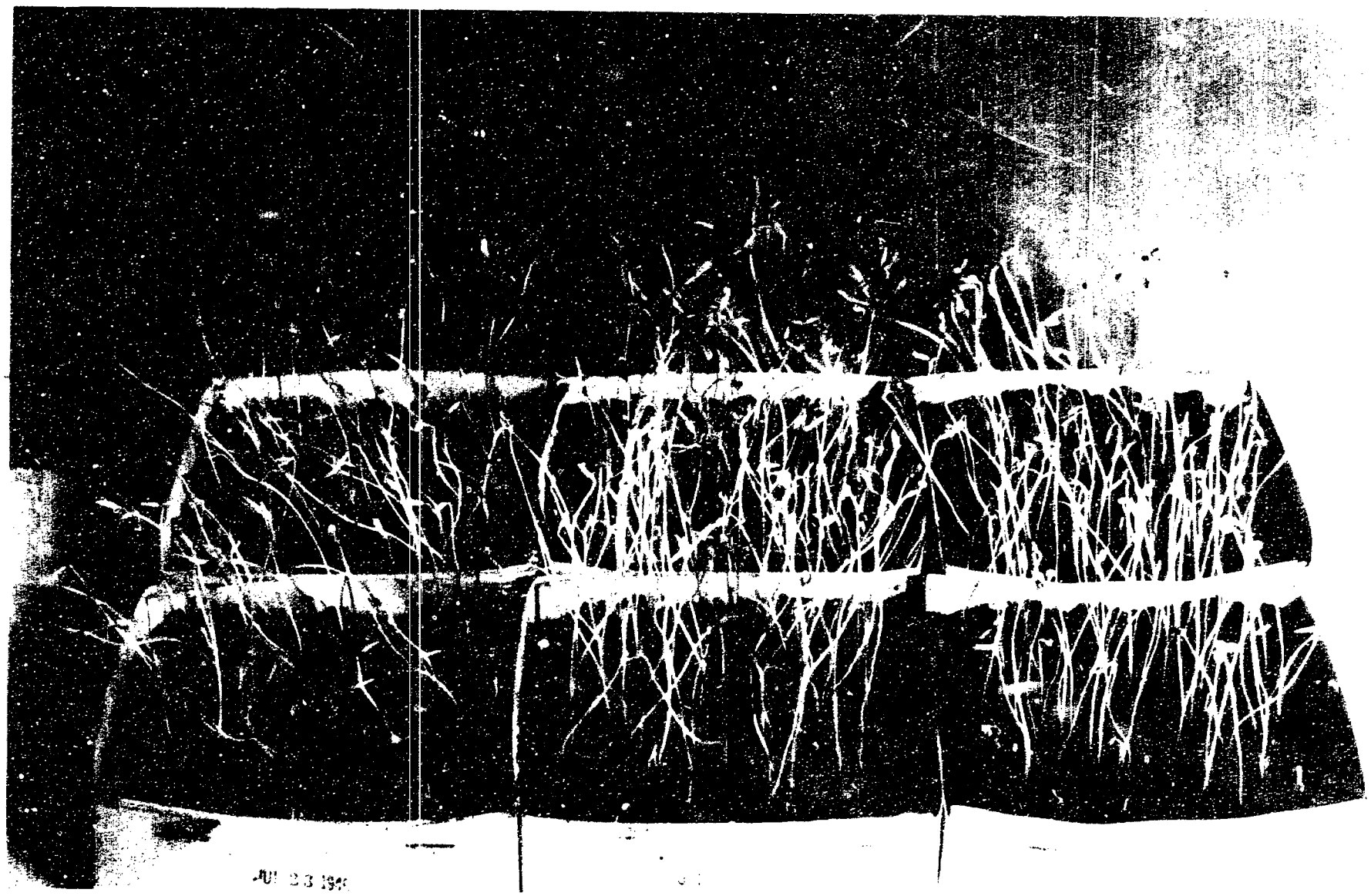


Fig. 1

6 day germination in the laboratory of seed of Sudan grass and Pan American tomato in unexposed Houston (a), Caribou (B), and Decatur (C) soil. (Photo by L. Guernsey)



a b c

Fig. 2

10 day germination in the laboratory of seed of Pan American tomato in unexposed Houston (a) , Caribou (b), and Decatur (c).

Defense Special Weapons Agency
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Alexandria, Virginia 22310-3398

TRC

10 April 1997

MEMORANDUM FOR DEFENSE TECHNICAL INFORMATION CENTER
ATTENTION: OMI/Mr. William Bush

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency (formerly Defense Nuclear Agency) Security Office has reviewed and declassified the following reports:

AD-366718	XRD-32-Volume 3
AD-366726	XRD-12-Volume 2
AD-366703	XRD-16-Volume 1
AD-366702	XRD-14-Volume 2
AD-376819L	XRD-17-Volume 2
AD-366704	XRD-18
AD-367451	XRD-19-Volume 1
AD-366705	XRD-20-Volume 2
AD-376028L	XRD-4
AD-366694	XRD-1
AD-473912	XRD-193
AD-473891	XRD-171
AD-473899	XRD-163
AD-473887	XRD-166
AD-473888	XRD-167
AD-473889	XRD-168

AD-366705

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AD-B197749	XRD-174
AD-473905	XRD-182
AD-366719	XRD-33 Volume 4
AD-366700	XRD-10
AD-366712	XRD-25 Volume 1
AD-376827L	XRD-75
AD-366756	XRD-73
AD-366757	XRD-74
AD-366755	XRD-72
AD-366754	XRD-71
AD-366710	XRD-23 Volume 1
AD-366711	XRD-24 Volume 2
AD-366753	XRD-70
AD-366749	XRD-66
AD-366701	XRD-11
AD-366745	XRD-62.

All of the cited reports are now **approved for public release; distribution statement "A" applies.**

Ardith Jarrett

ARDITH JARRETT
Chief, Technical Resource Center

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